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Foliar Epidermal and Petiole Anatomical Studies of Some Nigerian Species of *Ipomoea* (Convolvulaceae)

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Abstract

The foliar epidermis and petiole anatomical studies were conducted on five species of *Ipomoea* in Southwestern Nigeria in search of useful and stable taxonomic characters for the identification of the species. Morphological features among the taxa revealed striking similarities in their habits. All the species shared common attributes in their twinning stem and leaf shape except *Ipomoea aquatica* which stayed apart by the possession of sagittate leaf with alternate arrangement. The petiole anatomy showed diagnostic characters that are of taxonomic value. The results showed substantial variations in the type and shape of epidermal cells from straight to polygonal and up to wavy. Preponderance of trichomes on the abaxial surface of *I. triloba* could be used to delimit the species. The study provides referential pharmaco-botanical information for the correct identification of the species.

Key words: Foliar epidermis, Anatomy, *Ipomoea*, Nigeria

INTRODUCTION

Ipomoea is one of the largest genera of the family Convolvulaceae with over 500 species, most of which are called morning glories, moon vine, cypress vine and sweet potato. The family itself consists of 50 genera and 1200 species in the world (Lawrence, 1951). The genus *Ipomoea* occurs throughout the tropical and subtropical regions of the world. The use of data generated from leaf epidermal surface in resolving the taxonomy of taxa has gained much recognition (Aworinde and Ogundairo, 2009; Kadiri and Olowokudejo, 2010; Ogundipe *et al.*, 2009; Tayade and Patil, 2011). Leaf occupies a prominent position in this consideration and their various features such as venation, stomata and trichomes have proven useful in the resolution of certain taxonomic and phylogenetic problems along with those of general morphology and histogenesis (Quesada, 1997). In view of the above consideration and the great diversity of habit and adaptations exhibited by the various species of the genus *Ipomoea*, this present study investigates the leaf epidermal morphology alongside the petiole anatomy of five species of the genus in Nigeria with a view to establishing striking differences and similarities that could be used in further delimitation of the taxa.

MATERIALS AND METHODS

Plant samples used were collected from different regions covering Southwestern Nigeria; the Botanical gardens of University of Ibadan,

Ibadan, Obafemi Awolowo University, Ile-Ife, Federal University of Agriculture, Abeokuta and University of Lagos, Lagos. Identification of the taxa was done at the Forestry Herbarium Ibadan (FHI). Measurement of parameters for morphological data followed Isawunmi (1989). Specimens were prepared for permanent slides as described by Aworinde and Ogundairo (2009). Stomata frequencies and indices were calculated from the counts of stomata and epidermal cells per unit area. Description of stomata followed Metcalfe and Chalk (1950) and Stace (1965). Stomatal Index was calculated as defined by Salisbury (1927). Terminologies related to epidermis followed that of Metcalfe and Chalk (1950) and Wilkinson (1979) and trichomes mainly after Rammaya and Rajgopal (1980) and Vijay (1988). For the petiole anatomy, the petioles were fixed in FAA and preserved in 70% alcohol. Microtome sections of petiolar median were stained in 1% safranin, counterstained in 1% fast green and dehydrated following the method of Johansen (1940). Photomicrographs were taken using CCD digital camera (DK 5000) fitted on Leica light microscope (DM 1000).

RESULTS

Macro morphological characters

All the taxa generally have common morphological features such as twinning, creeping and stoloniferous weak stem habit. They can also be easily recognized by funnel shape, radially symmetrical colourful flowers. The leaves of the taxa are simple, alternate and exstipulate. In terms of leaf shape, they have a characteristic heart shape "cordate" except *I. aquatica* having a sagittate shape and *I. asarifolia* with a reniform shape (Table 1). *I. triloba* has the highest leaf length (20.5cm) while *I. involucrata* has the lowest leaf length (2.5cm). The highest leaf width was observed in *I. triloba* (19.4cm) and the lowest in *I. involucrata* (2.4cm). The leaf length /width ratio ranges from 1:2 in *I. asarifolia* to 1:1 in *I. triloba*.

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Micro morphological characters

Epidermal cells

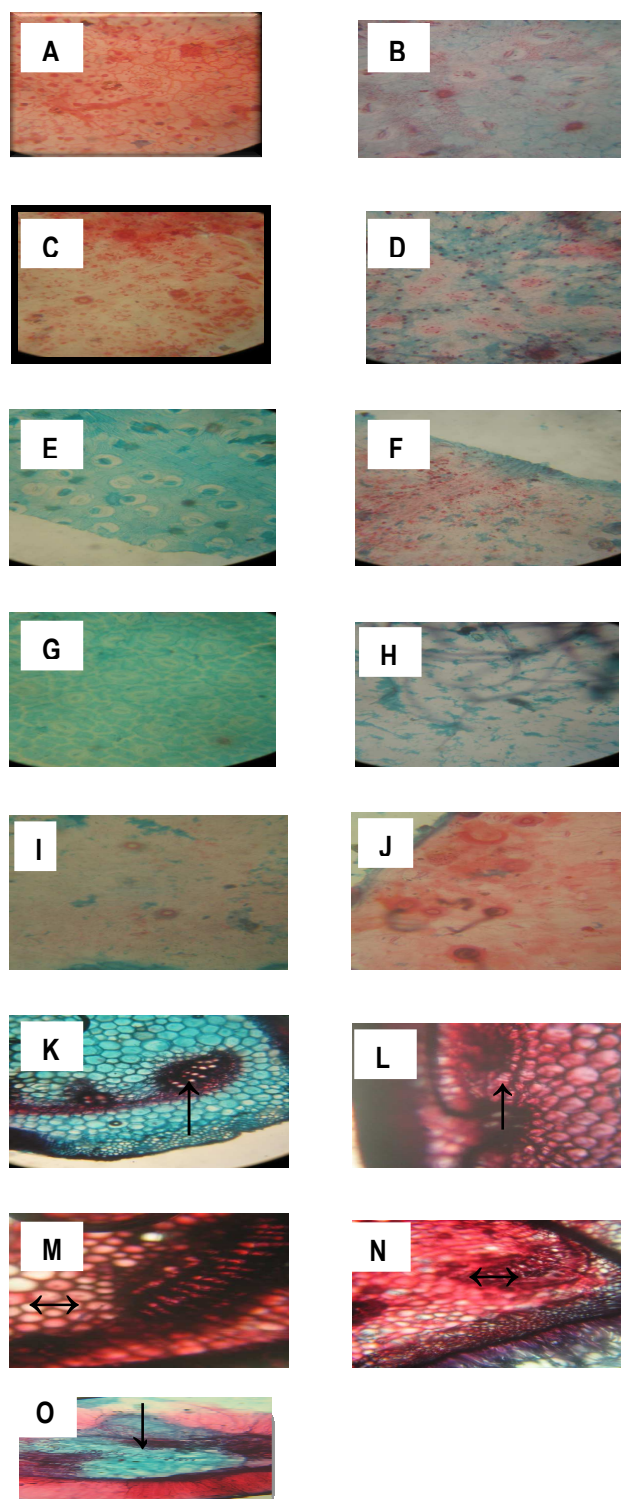
Epidermal cells are more often irregular in adaxial surfaces and polygonal in abaxial surfaces in species such as *I. batatas*, *I. asarifolia* and *I. triloba*. The cell shapes of the abaxial surfaces of all the taxa are more often polygonal except in *I. asarifolia* and *I. triloba* which have irregular cell shapes. Wavy anticlinal wall pattern was found on the irregular cell of *I. batatas* and *I. asarifolia* (Table 2). Curved to straight walls characterized by irregular and undulating cell shape were found in abaxial and adaxial surfaces of *I. triloba*. The epidermal cells are moderately thick ranging from 0.33 μm in *I. asarifolia* and 0.56 μm in *I. aquatica* on the adaxial surface and 0.31 μm in *I. triloba* and *I. involucrata* and 0.54 μm in *I. asarifolia*.

Stomata

All the leaves were amphistomatic having stomata at both the adaxial and abaxial surfaces of their leaves. The parallelocytic, paracytic and anomocytic stomata types are prominent in the studied species. *I. involucrata* showed anomocytic on the adaxial surface while it was parallelocytic stomata in *I. batatas*, *I. aquatica* and paracytic in *I. asarifolia* and *I. triloba*. Stomata index ranged from 9% to 21% in *I. asarifolia* and *I. triloba* respectively on the abaxial surface while it ranged from 10% to 28% in *I. asarifolia* and *I. aquatica* on the adaxial respectively (Table 1).

LEGEND for Figures

- A:** Adaxial surface of *Ipomoea batatas* showing parallelocytic stomata and wavy anticlinal wall
B: Abaxial surface of *I. batatas* showing parallelocytic stomata and straight anticlinal wall
C: Adaxial surface of *I. asarifolia* showing paracytic stomata and wavy anticlinal wall
D: Abaxial surface of *I. asarifolia* showing anisocytic stomata and curved anticlinal wall
E: Adaxial surface of *I. aquatica* showing parallelocytic stomata and curved anticlinal wall
F: Adaxial surface of *I. aquatica* showing parallelocytic stomata and curved anticlinal wall
G: Adaxial surface of *I. triloba* showing paracytic stomata and curved to straight anticlinal wall
H: Adaxial surface of *I. triloba* showing anomocytic stomata and straight anticlinal wall
I: Adaxial surface of *I. involucrata* showing anomocytic stomata and straight anticlinal wall
J: Adaxial surface of *I. involucrata* showing anomocytic stomata and curved anticlinal wall
K: T.S of petiole of *I. batatas* showing collateral vascular bundle
L: T.S of petiole of *I. aquatic* showing collateral vascular bundle
M: T.S of petiole of *I. triloba* showing parenchyma cells
N: T.S of petiole of *I. involucrata* showing parenchyma cells
O: T.S of petiole of *I. asarifolia* thick epidermal cell



↑ = Vascular bundle, ↔ = Parenchyma cells, ↓ = Thick Epidermal cell

Trichome

Trichomes are present only in *I. triloba* and *I. involucrata*. Unicellular, unbranched trichomes are predominantly found on the abaxial surface of *I. triloba* but reduced on the adaxial surface. Few short trichomes were observed on both surfaces in *I. involucrata*.

Petiole Anatomy

Varieties of shapes and internal structures of the transverse section were observed in the petiole of each taxon. Crescent shaped with undulate walls were noted at the proximal, median and distal regions in *I. batatas* (Fig. K). Semi circle to boat shape at the regions in *I. aquatica*, adaxial surface slightly raised at the median region, strongly winged ribs pointed at the distal region. The adaxial surface has an angular depression at the mid portion of the three regions. *I. asarifolia* had a semi circle shape without ribs at the distal, proximal and median regions. Saucer to boat shape found in *I. involucrata*, grooved at the adaxial end and extended into short ribs with pointed ends. Cortex demarcated into outer colenchyma and inner parenchyma cells, thin walled parenchyma enclosing moderately small sized intercellular spaces in all taxa. There are 6-8 layers of collenchyma cells 6-8 layers in *I. triloba* and 5-6 layers in *I. batatas*. Also, five collateral vascular bundles arranged in semi circle in *I. asarifolia*, three strands of bundles at the centre of *I. batatas* arranged in an arc shape, 6-7 bundles arranged in circular arrangement in *I. aquatica*, 6 bundles in a semi circle in *I. triloba* and 4 isolated bundles arranged in a circular arrangement in *I. involucrata* (Figs. K - O).

Table 1: Leaf morphological features of the taxa

Taxa	1	2	3	4	5	6	7	8	9	10	11	12
<i>Ipomoea batatas</i>	+	-	-	+	-	+	-	-	+	-	+	-
<i>I. asarifolia</i>	-	+	-	+	-	-	+	+	-	+	-	-
<i>I. aquatica</i>	+	-	-	+	-	+	-	-	-	+	-	-
<i>I. triloba</i>	+	-	-	+	-	+	-	-	+	-	-	+
<i>I. involucrata</i>												

Legend to character codes: 1= cordate leaf shape, 2 = reniform leaf shape, 3 = sagittate leaf shape, 4= cordate base, 5= sagittate base, 6= acute apex, 7= retuse apex, 8= acuminate apex, 9= entire margin, 10= ciliated margin, 11= glabrous leaf, 12= pubescence leaf.

Table 2: Adaxial epidermal characters of the taxa

Taxa	1	2	3	4	5	6	7	8	9
<i>Ipomoea batatas</i>	+	-	+	-	-	-	+	-	-
<i>I. asarifolia</i>	+	-	+	-	-	-	-	+	-
<i>I. aquatica</i>	-	+	-	-	+	-	+	-	-
<i>I. triloba</i>	+	-	-	-	-	+	-	+	-
<i>I. involucrata</i>	-	+	-	+	-	-	-	-	+

Legend to character codes: 1= irregular cell shape, 2= polygonal cell shape, 3= wavy anticlinal wall, 4= straight anticlinal wall, 5= curved anticlinal wall, 6= curved to straight anticlinal wall 7= parallelcytic stomata, 8= parasitic stomata, 9= anomocytic stomata

Table 3: Abaxial epidermal characters of the taxa

Taxa	1	2	3	4	5	6	7	8	9
<i>Ipomoea batatas</i>	-	+	-	+	-	-	-	+	-
<i>I. asarifolia</i>	+	-	-	-	+	-	-	-	+
<i>I. aquatica</i>	-	+	-	-	+	-	+	-	-
<i>I. triloba</i>	-	+	-	-	+	-	-	+	-
<i>I. involucrata</i>									

Legend to character codes: 1= irregular cell shape, 2= polygonal cell shape, 3= undulating irregular cell shape, 4= straight anticlinal wall, 5= curved anticlinal wall, 6= curved to straight anticlinal wall 7= parallelcytic stomata, 8= anomocytic stomata, 9= anisocytic stomata.

Table 4: Variation in epidermal cell size and cell wall thickness of the taxa.

Taxa	No. cells per view min (mean \pm s.e) max		Cell wall thickness min (mean \pm s.e) max	
	Adaxial	Abaxial	Adaxial	Abaxial
<i>Ipomoea batatas</i>	116(201.3 \pm 19.9)316	112(207.4 \pm 24.8)346	4(6 \pm 0.5)9	4(6.2 \pm 0.4)8
<i>I. asarifolia</i>	83(225.8 \pm 28.7)320	129(325.4 \pm 32.8)440	5(6.2 \pm 0.3)8	3(5.5 \pm 0.5)9
<i>I. aquatica</i>	50(137.2 \pm 18.4)218	128(297.4 \pm 33.6)440	3(5.6 \pm 0.5)9	4(5.5 \pm 0.4)8
<i>I. triloba</i>	115(204.6 \pm 20.6)316	12(59.3 \pm 10.3)112	4(5.9 \pm 0.5)9	4(5.6 \pm 0.3)7
<i>I. involucrata</i>	118(302 \pm 34.6)463	176(252.3 \pm 19.8)361	3(4.5 \pm 0.4)6	3(4.9 \pm 0.3)6

DISCUSSION

The results of the foliar anatomy and leaf epidermal features of *Ipomoea* species studied showed some characteristics that could be used for taxonomic decision. Morphologically, the vegetative features and habits of the genus are useful tool in their taxonomic similarity which has been emphasized by Vijay and Ramaya (1987) and Vijay (1988). Tayade and Patil (2011) reported that *Ipomoea* have some phenotypic uniformity and there is a great deal of variability and diversity in their internal structures. Stomata are generally paracytic on adaxial and abaxial surfaces in the species investigated. Different stomatal types are also observed rarely in few species. Stomatal abnormalities are by now thought to be frequent in Angiosperm and are conceived to be freaks during stomatal ontogeny (Aworinde and Ogundairo, 2009). The stomatal index has been found useful in diagnosis of some species. Based on the most reliable features that are reported in the present study, this can serve as baseline upon which further researches such as molecular and phytochemical studies could stand. High values of stomata density generally on the abaxial surface of all the taxa are greater than that of the adaxial surface, a coping strategy for water conservation (Adegbite, 2008; Nbagwu et al., 2008). Superficial character of the petiole can be of descriptive and taxonomic value. This may include presence or absence of pulvinus, presence or absence of stipules, glands, pubescence etc. One aspect worthy of note is the general outline of the petioles in the distal, median and proximal regions, because two taxa may have the same outline and shape (Aworinde et al., 2012). *I. batatas*, *I. asarifolia* and *I. triloba* demonstrated anatomical similarities in their shape, cortex (parenchyma and collenchyma); although polygonal parenchyma is common to all taxa.

CONCLUSION

The foregoing anatomical illustrations presented make it apparent that some of the epidermal characters/features are constant for the genus, while others are distinctive of the species.

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